



NTSB UAS Safety Forum

Design for Airworthiness

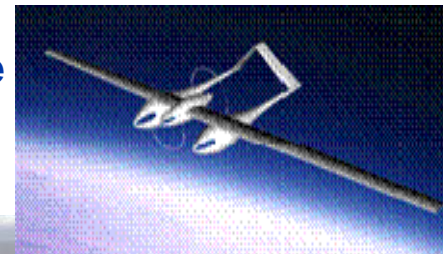
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Program Manager A160 Hummingbird
Advanced Systems
Washington DC
April 30, 2008

Boeing's Broad Range of UAS'

All are considered Public Aircraft
Designed & Certified in compliance with customer requirements

Requirements Dictate Complexity,
Design and Certification

High Altitude
Long
Endurance



X-45



A160 Hummingbird



Unmanned Little Bird



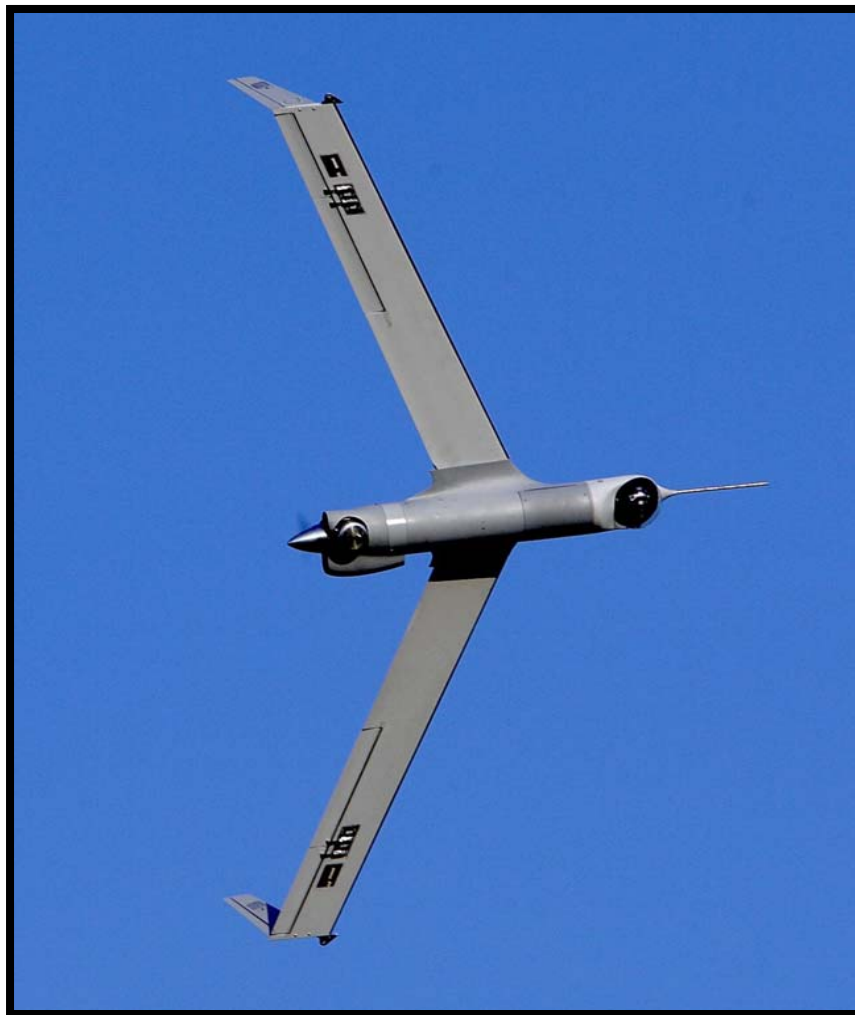
Varied Requirements

- Mission
- Endurance
- Mobility
- Speed
- Sensor size and weight
- Survivability

ScanEagle



ScanEagle



- Wingspan 10 ft
- Length 4 ft
- Diameter 7 in
- Max Gross Weight 43 lbs

- Land / Sea Capable
- No Runway Requirements

- Max Level Speed 75 kts
- Cruise @ max wt 48 kts
- Ceiling @ max wt 16,000+ ft
- Endurance 20+ hours

Directives

- Developed specific UAS Flight Operations Directives
- Tailored and Applied First Flight Readiness and Flight Certification Review processes to Unmanned Aircraft Systems
- Utilize DoD Processes (MiL Hdbk 516B, NAVAIRINST 13034.1C, etc.)
- Establishes Airworthiness Certification at the UAS level
- Compliant with Airspace Authorities for Certification Verification



Unmanned Little Bird (ULB)

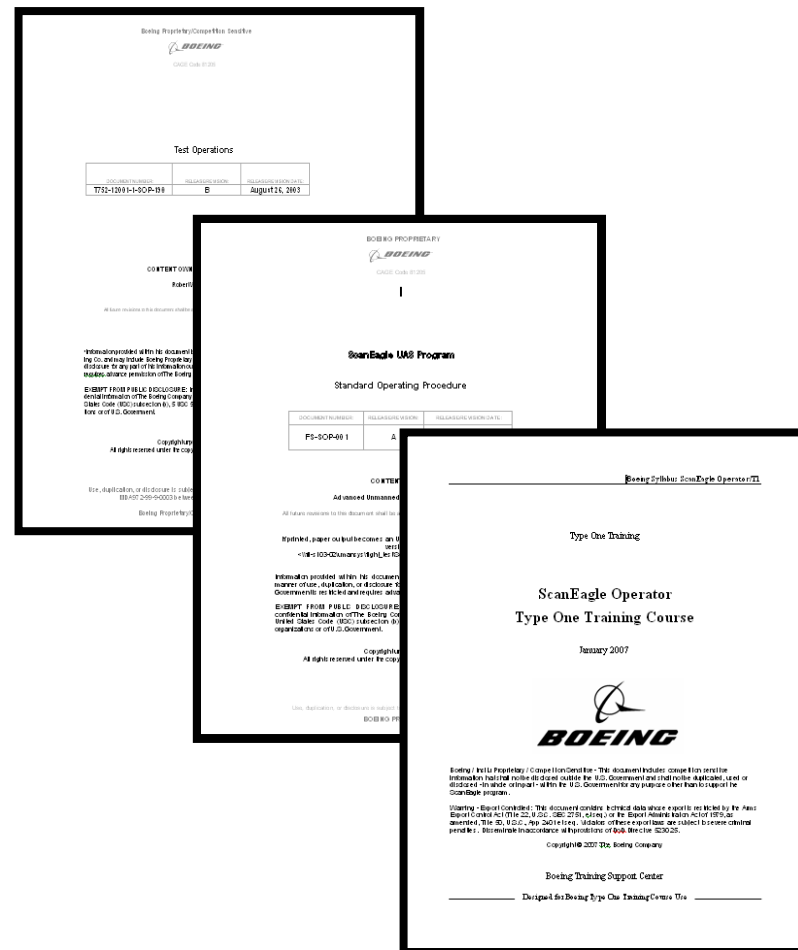
- Manned/Unmanned UAV
- Existing fielded airframe (A/MH-6M manned aircraft)
- 10 hours of endurance*
- 450 nm radius*
- 2400 lb payload/fuel
- EO/IR Sensor
- Target tracking
- Robust communications suite
- Rapid manned/unmanned transition
- Ground station with integrated mission management

* with larger auxiliary tank



Procedures Development

- Standard Operating Procedures developed for each UAS program
 - System requirements
 - Mission requirements
 - Operator requirements
 - Safety / Test Hazard Analysis
 - Weather requirements
 - Service Guidance / GFR
- Comprehensive Training
- Emergency Procedures checklist developed for each UAS



A160 Hummingbird

**Rotor
Diameter:**
36 ft

**Fuselage
Length:**
35 ft



**Gross
Weight:**
4,000 -
5,000 lb

**Internal
Payload:**
300 -
1000 lb

Performance Goals

Range:
2,500+ NM

Endurance:
32 hr at 15,000 ft

Speed:
140 kt

Ceiling:
15,000 ft Hover
30,000 ft Cruise

Aviation Safety

- Aviation Safety and System Safety Processes applied to UAS'
- Develop & Implement UAS Operational Risk Management Plan
- Develop System Safety Program Plan
- Conduct Hazard Analysis
- Implement Controls to Reduce Risk
- Investigate incidents

Boeing - St. Louis
Flight Test Operating Directive 6.1
Issue Date: 18 November 2005
Contents

FTOD 6.1 Mishap Prevention Program

Purpose/Summary
Aviation Safety, under the direction of the Aviation Safety Office (ASO), is responsible for managing or overseeing a myriad of tasks and sub-programs that comprise the Flight Test "Mishap Prevention Program". These tasks or sub-programs are listed separately below with brief descriptions of each.

Supersedes
FTOD 6.1 dated 21 March 2003

Applies to
Engineering
Test and Evaluation
Test Operations
Product Safety Department
Production Aircraft Programs

Maintained by
People to
Authorize
Authority
Implement

Approved by
President
Director
Definition
None

Requirements
1. All
a.
b.

Boeing
ScanEagle
Risk Assessment Worksheet

Boeing
ScanEagle
Flight Operations Hazard Analysis & Operational Risk Management Plan

Prepared for:
The Federal Aviation Administration

Hazard Analysis and Risk Assessment
ScanEagle Unmanned Aerial Vehicle

| Hazardous Condition | Cause | Effect | Hazard Level/Severity Assessment | Controls / Precautionary Measures | Corrective Actions |
|-----------------------------|---|---|----------------------------------|---|--|
| Loss of Communications Link | • Collocated flight computer failure • Corrosion | • Loss of flight data • Loss of mission • Loss of situational awareness • Loss of flight data • Loss of flight data | Low | • A pre-programmed radio will be used to maintain contact in emergency situations • The flight data will be stored on a separate system to ensure data integrity • Use of flight data recorder to monitor flight data | • Follow emergency procedures for loss of communications • Prepare for flight data recorder failure |
| Loss of Engine Power | • Engine failure | • Loss of thrust • Loss of altitude • Loss of situational awareness • Loss of flight data • Loss of flight data | Low | • The engine will be monitored continuously • The engine will be monitored continuously • The engine will be monitored continuously • The engine will be monitored continuously • The engine will be monitored continuously | • Follow emergency procedures for engine failure • Prepare for engine failure |
| Loss of Engine Power | • Engine failure | • Loss of thrust • Loss of altitude • Loss of situational awareness • Loss of flight data • Loss of flight data | Low | • The engine will be monitored continuously • The engine will be monitored continuously • The engine will be monitored continuously • The engine will be monitored continuously • The engine will be monitored continuously | • Follow emergency procedures for engine failure • Prepare for engine failure |
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High Altitude Long Endurance (HALE)

Operational Need: Extreme Endurance in the Stratosphere

- Battlefield and Border Observation
- Port Security
- Telecommunications

Enabling Technologies:

- Hydrogen Propulsion
- Highly Reliable Subsystems
- Lightweight Structures
- Thermal Management



Breakthrough Capability:

- 7+ Days Endurance
- Up to 2000 lbs Multi-Sensor Payload

Summary

- Boeing has considerable experience designing, developing, certifying and operating a wide variety of fixed and rotary wing UAS'
- Boeing's primary focus is centered on delivering a UAS capability that meets or exceeds our public-use customers' expectations
- Boeing utilizes effective company-wide and customer specific policies, procedures and directives for manned and unmanned aircraft that ensure -

“The commitment to aviation safety shall begin with the design and manufacture of aircraft and related components and continue through testing, operations, and post-delivery support.”